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ABSTRACT

This document presents a general review of distance education as it currently pertains to secondary, postsecondary, and adult education. Chapter I discusses the general concepts of distance education. It addresses the nature of distance education and distance delivery, the distance learner, the distance instructor, and distance education learning materials and teaching methods. Examples of distance education and distance delivery are provided. Chapter II presents, compares, and contrasts technologies associated with distance delivery. These technologies include print materials, audio technologies, audio graphic, full-motion video, and computers. A matrix presents the technologies in one dimension and general, learner, teacher, and pedagogical considerations in the other dimension. Chapter III discusses interactive television separately. Matrix 2 compares and contrasts the various interactive television technologies. Costs, advantages, and limitations are considered. The final chapter contains a summary and conclusions. A bibliography is divided into five areas: distance education--background, technologies, distance delivery systems, pedagogical issues, and research issues and studies. (YLB)

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Distance Delivery of Vocational Education Technologies and Planning Matrixes

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August 1987

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ABSTRACT

Distance education and distance delivery are concepts that are currently receiving much attention. The purposes of this paper are to: 1) contrast distance education with conventional education thereby alerting the reader to important differences especially in the roles of the instructor and learner and in the learning environment; 2) cite examples of institutions using distance delivery; 3) describe the technologies used by distance education; 4) compare and contrast the technologies and the learning environments of each; and 5) develop a reading reference bibliography. The discussion is primarily, though not exclusively, concerned with postsecondary vocational and adult education.

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CHAPTER I

BACKGROUND

Introduction

Much discussion today both inside and outside of education is focused on the socio-economic changes being brought about by the emerging information age, the rapid changes in technology and communications, the emerging global economy and changes in population demographics (Reich, 1983; Zigerell, 1984). In education, much of the discussion is being centered on meeting the needs of an increasingly diverse student population in need of training, retraining and updating of skills to acquire new jobs or to keep current in present occupations. Additionally, there is a perception that educational opportunities should be made available to anyone who desires them and in a convenient manner. This includes those restricted by present jobs, family and financial responsibilities, physical handicaps, the homebound, and those unable to relocate for educational purposes. However, while educators are aware of these needs and are seeking to find ways to provide the necessary educational opportunities they are faced with declining budgets which result in reductions of staff, program cutbacks and fewer capital and equipment purchases. Education, including vocational education, finds itself in a particularly challenging albeit urgent situation. If current prognastications are correct this situation will intensify in the years ahead.

While much of the cause of the present state of affairs can be attributed to changing technology, it is these same technological advances, especially in communication, that offer solutions to this dilemma faced by educators (Crooks, 1983). Rapid advances are taking place in the equipment and include means of encoding, transmitting and receiving communications, making it possible to reach learners at remote locations with quality education in a variety of ways with some that are akin to the learner actually being physically present. While these approaches depart from the conventional means of instruction, they none-the-less provide viable alternatives for educators to deliver quality instruction to those who desire it. These alternative means of delivery are referred to in the literature as distance education and distance delivery. While the concepts are not new and have been attempted via correspondence schools, radio, educational television and computers, new technological advances and improvements are making distance delivery of education much more attractive as a means for providing education.

Vocational educators are showing a strong interest in these alternative means of delivering education as exemplified by the February 1985 national

survey conducted by the Teacher Education and Staff Development Committee of the American Vocational Association to identify critical issues facing vocational teacher education. In the survey, the development, funding and implementing of delivery systems "new and innovative, i.e., telecommunications, interactive video, etc." ranked 16th out of the 68 critical issues identified by the survey (Zeller and Parrish, 1986). Thus, it is important for vocational educators to explore the various technologies available and to use them in effective ways.

The purpose of this study is to present a general review of distance education as it currently pertains to secondary, post-secondary and adult education. To accomplish this, the general concepts of distance education are discussed. Secondly, technologies associated with distance delivery are presented, compared and contrasted. The impetus for this study emanates from committee recommendations based on Dr. Jerry McClelland's paper Adult Education and Vocational Education: Implications for Research on Distance Delivery (McClelland, 1986). Research for this study is based on a review of the literature, school and on-site industry visitations and personal interviews. While there is a fair amount of general discussion regarding distance education and distance delivery in the literature, it was found that to date little research on many of the concepts and technologies presented in this study has been done. This is due to the recency of renewed interest in distance education and the rapidly changing technological picture.

Before discussing the nature of distance education and distance delivery it is necessary to define these terms and to identify the associated technologies. Distance education in its broadest definition is education that is characterized by the physical separation of the learner(s) and the instructor with the interactive phase of teaching being conducted through print, mechanical and/or electronic means. It is a generic term that includes a wide range of teaching and learning strategies (Holmberg, 1977; Rumble and Harry, 1982; Law and Sissons, 1985). The term distance education is often referred to in the literature as open learning, nontraditional studies, independent learning and correspondence studies.

Distance education is rapidly becoming a global phenomenon, with learning institutions in this country and in many countries abroad developing both formal and informal courses. The approach taken varies from country to country and is often influenced by resources available, social structures and demands for education. Distance education in this country is characterized by its pragmatic trial and error approach with little consideration being given to theoretical basis, while Europeans generally view it as an emerging theory-based discipline of education (Holmberg, 1977; Sparkes, 1983; Zigerell, 1984).

While distance education describes the activity, distance delivery focuses on the technological means of delivering the instruction. While these terms are often used interchangeably, a distinction does exist. It is necessary to keep the organization, content and other pedagogical concerns and the means of delivering the instruction to the learner at remote sites in proper perspective. Winn (1985) points out that while technologies for delivering distance education can be very impressive, it can be a trap into which to fall. Sound distance education is the result of effective communication and instruction and adherence to sound instructional principles.

A third term that is often used to describe distance delivery is telecommunications. Originally, it referred to telephone communications. However, it is typically used today in a much broader way to include audio, video and data transmission by radio, television, telephone, computer or cable (Dean, 1985). Thus, while it is a term that is used in a variety of ways to mean a variety of things, it usually suggests some type of immediate, electronic interactivity exists between the learner and the instructor.

There are a wide range of technologies that can be used solely or in combination with other technologies to deliver education to the learner. Table 1 illustrates the various technologies and their modes of delivery. Because clear distinctions between the technologies are hard to make, this table merely serves as a means of organizing the various distance delivery technologies for discussion purposes. Detailed descriptions of the technologies appear in Chapter II of this study.

Nature of Distance Education and Distance Delivery

The three main elements in distance education are the learner, the means of delivery and the instructor or institution providing the instruction. While distance education is in many respects similar to conventional instruction, important differences exist especially in regard to the role of the distance learner, the role of the instructor, and the associated pedagogy. These differences are due to the fact that the learner and the instructor are physically separated during much or most of the instruction. Before discussing these differences, it is necessary to classify distance education in terms of interactivity and the relationship between the learner and instructor.

Scales (1983) developed a typology that classifies distance education into 6 types (see Figure 1). Interactivity in this typology is described in terms of both human interactions with other humans and human interactions with machines such as computers and interactive video. In Type I, instruction is delivered through a one-way non-interactive media or media combination such as print, audio or video. Type II instruction is characterized by two-way delayed communication between learner and instructor. Examples include interaction of printed materials through the mail or an exchange of audio cassettes. Type III instruction includes immediate two-way interaction between the learner and instructor via direct telephone contact or through interactions via the microcomputer. In Type IV the learner-instructor interaction is expanded to include other individuals and groups and is accomplished by teleconferencing (audio-only) or live-interactive television, which could be fully two-way audio and visual depending on the technology used. Type V includes occasional face-to-face interaction through seminars or lab experiences. Finally, Type VI provides face-to-face instruction through extension programs, lecture series or satellite campuses. This type would be analogous to conventional instruction with the use of means other than face-to-face at a minimum. As can be observed, interactivity increases as one proceeds from Type I to Type VI. At the same time learner self-sufficiency decreases as the active involvement of the instructor and/or education institution expands.

Table 1

Distance Delivery Technologies

Category	Technology	Delivery Mode
Print	Printed Materials (Programmed Instruction Guided Lessons); Lab Kits	Mails
Audio	Audio Tapes	Mails
	Radio	Radio transmission
	Dial-access telephone	Direct dial to instructor
	Dial-up teleconferencing	Operator assisted
	Meet-me bridges	Leased lines from private companies or from major telephone supplies, direct dial or operator assisted.
	Dedicated networks	Permanent connections to training sites.
Audio-Graphic	Electronic blackboard	Telephone
	Slow-scan, Facsimilie; compressed video	
Full-Motion Video	Instructional Television Fixed Service (ITFS)	Microwave
	Television: Low Power	VHF, UHF
	Broadcast	Microwave; satellite
	Interactive Television	Microwave; cable; fiber optics; satellite
	Video-tape	Mails
	Interactive video disc (tape)	Mails
Computer	Microcomputer	Mails
	Remote terminals	Telephone
	Central computers	Telephone
	Videotex	Standard telephone

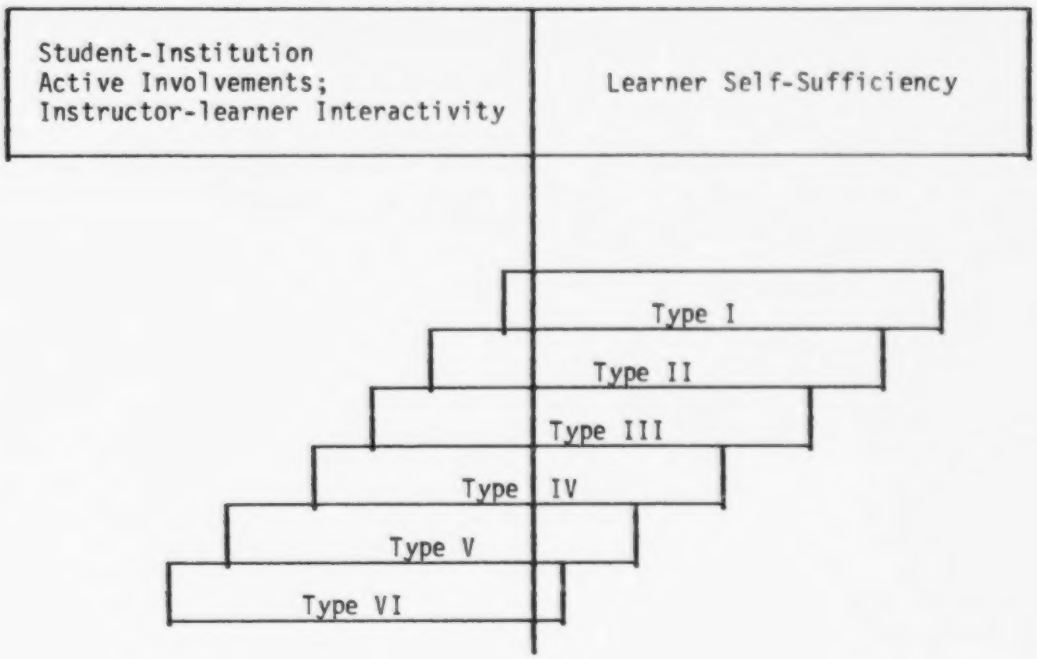

Figure 1 - Types of Interactivity

This model is helpful not only in classifying the types of distance education, but in providing a continuum by which to measure and describe the various learner instructor and technological interactions.

The Distance Learner

Because of the potential accessibility to distance education, the composition and nature of the student population may be quite different from the traditional homogeneous student populations that characterize much of conventional education. Distance learners may differ in two important ways. First, distance education will provide opportunities for people who now desire education but have difficulties in going to a learning institution to obtain it. Homemakers, the homebound, the incarcerated, people working full time, and those reluctant to attend traditional classes will have access to education. Because of the diversity of the potential population of learners, classes will be very heterogeneous (Kaye and Rumble, 1981; Zigerell, 1984). A class for a particular course then could be made up of students with a wide range of ages and with varying degrees of motivation, experiences and educational backgrounds. The degree of heterogeneity would be determined in part by the choice of delivery technology, accessibility by the learners, and the nature of the course. For example, a course offered over educational television would reach a very

heterogeneous group. This is not to suggest that all classes would be this diverse. A course on basic electricity over an inter-active television system between cooperating high schools comprised of full-time high school vocational students would be quite homogeneous in terms of age and experience.

Secondly, with distance education, much of the control of the instruction and the responsibility for the outcome resides with students (Scales, 1983; Kaye and Rumble, 1981; Law and Sissons, 1985). Depending on the technology employed students can exert control over the time and location of the learning. Referring to the typology in Figure 1, one would expect the control over time and location to be greatest with Types I, II and III. Learners receiving instruction via print or audio tape, for example, would be free to study anywhere at anytime. Thus, the learner autonomy and the degree of control exerted over the learning situations by the learner have important ramifications and require many modifications to the usual ways students are viewed.

The Distance Instructor

As with the distance learner, the distance instructors will find their role altered by distance education. Because of a theoretical shift that puts the focus on the learner rather than the instructor, learning becomes more independent of the instructor (Feasly, 1982; Law and Sissons, 1985). This has several implications for the instructor. First, the instructor becomes more of a facilitator than a teacher (Keegan, 1983). Depending on the technology employed, the instructor's role would be to design instruction and activities that would aid the more independent learner. This would include providing supplementary materials, utilizing outside experts, designing electronic field trips and the like. It would then follow that distance instructors would give up some of their autonomy and out of necessity would have to work with many others in the design and delivery of instruction. Again, depending on the nature of the technology employed, instructors could be working with curriculum design specialists in the writing of individualized learning materials, working with media production people and camera crews, or even taking voice and acting lessons to enhance the quality of delivery. This course-team approach would be beneficial in many ways (Holmberg, 1984).

Another implication would be that distance learning would become a cooperative effort between the learner and instructor. Again, because distance education is more learner centered, the instructor would need to work with a more diverse group of students to ascertain their individual wants and needs and to develop strategies with them to meet their educational goals and objectives. This would involve a greater individualization of the learning situation characterized by flexibility, modification, and continual feedback. This would be in contrast to the more conventional educational approach where the curriculum is seen as transmission of subject matter, teaching as telling, and learning as the acquiring of facts and information (McBeath, 1985). Also implied in this would be the fact that significant amounts of time and attention would be required to be devoted to the design of instruction and curriculum.

In summary, distance education instructors would find their roles significantly changed. It would be a role that would necessitate greater flexibility and cooperation with others in a more learner-centered environment.

This change in the role of the instructor may cause negative reactions by many instructors called upon to teach on a distance delivery system (Purdy, 1983). This will necessitate workshops and seminars to familiarize and update instructors with distance education and delivery.

Distance Education Learning Materials and Teaching Methods

As indicated above, distance education necessitates different approaches as to the design of instruction and the associated teaching methods. These methods are highly dependent on the nature of the technology used. It should be pointed out that a distance education instructor must do everything that a teacher in a conventional classroom does while keeping in mind that closer attention must be paid to the delivery system and to detail. As Winn (1985) points out, the various delivery systems do not allow certain flexibilities afforded classroom instructors. Liberties that the classroom instructor may take once in a while are not usually available to the distance instructor. Referring to Figure 1, one can clearly see that approaches to the design and delivery of instruction will vary greatly across the types even though the principles of instruction will remain constant. Certainly, instructional needs for the student working entirely from written materials in Type I differ greatly from the student receiving instruction via interactive television in Type IV.

Learning materials for distance education will need to be consciously and systematically designed, keeping in mind the characteristics of the delivery system to be used, the characteristics of the learners or target groups, and the nature of the course. A number of factors should be considered. The materials should build on the strengths of the various media, allow for a multi-media approach when necessary, and above all carefully match the materials to the technology being used by the students (Kaye and Rumble, 1981; Law and Sissons, 1985; Sparkes, 1983). Because of the central role printed materials play in distance education, they should be designed to create an impression of conversation and allow the learner to enter into the dialogue. While the model for traditional education is the textbook, the model for printed materials for distance delivery needs to allow for more flexibility and greater discretionary utilization by the learners. Suggested formats include looseleaf notebooks, materials that can be written on, logbooks and diaries (Holmberg, 1985; Law and Sissons, 1985). It is important with all distance materials that they be well planned, pilot tested and allow for feedback in some form.

Because of the physical separation of the learners from the instructor, two additional factors need to be considered. First, great care must be taken to avoid student misunderstanding at the beginning and throughout the course especially if the face-to-face element is missing (Hough, 1984; Morgan, 1984; Sparkes, 1983). Secondly, since course requirements and instructor expectations in the conventional setting are often conveyed informally between one generation of students and the next, it is important that requirements be presented in a detailed up-front manner with distance education. This is important even in the more interactive forms of distance delivery such as interactive television (Booth, 1982; Morgan, 1984).

A special consideration with distance education is the motivation of the student. Peruniak (1984) points out the isolation and resulting loneliness

that may occur with some forms of distance delivery and the motivational consequences. Additionally, since learning in general is more learner controlled, motivational problems can develop. This must be kept in mind when designing distance education instructional materials. Student motivation can be assisted in a number of ways. Course materials that pace student activity by using deadlines or incorporating regularly scheduled audio and video presentations are great motivators. In the case of highly individualized methods of instruction, periodic laboratories, seminars, computer activities and tutoring sessions can be used very effectively as motivators. Additionally, the availability of the instructor at certain times for telephone contact will aid in removing elements of dispair, help the student in overcoming difficulties as they arise and give impetus to the student to continue with the course of study.

As with the design of materials, special considerations regarding teaching also exist. Again the elements of good distance teaching include all the elements of good conventional teaching. Winn (1985) offers some helpful suggestions. As with designing materials, good delivery includes clarity; adaptation to the learner's experience, education levels and needs; relevancy; learner involvement; feedback; application of information; and speedy assessments. The distance instructor also should not take the technical facilities for granted. Technical problems can radically change the best of intentions without prior warning. Research regarding the teaching using the many distance delivery technologies is just beginning.

In summary, while all of the elements of conventional classroom instruction are present in distance education, the level of interactivity necessitates that special considerations must be made in the design and delivery of instruction. Table 2 is a summary table that presents a comparison of conventional education and distance education. Some of the items not yet discussed will appear in Chapter II.

Table 2

Education Dimensions

Dimensions	Conventional Education	Distance Education
Students	-relatively homogeneous	-potentially heterogeneous
	-at one location; controlled setting	-at remote sites (range from groups to widely scattered individuals), range from controlled to uncontrolled
	-dependent on instructor	-can be very independent of instructor
Student-Instructor Interactions	-immediate feedback	-limited by technology employed; range from immediate to prolonged delay
	-support built in	-support becomes a special consideration and must be provided for by dial access; seminar sessions; mailing and reminders, etc.
Role of Instructor	-traditional; instructor centered; teacher as a primary source of knowledge	-becomes more of a facilitator
	-usually works individually	-team effort
Instructor Mode of Delivery	-face-to-face	-mediated by technology
Methods	-skills fairly defined	-vary depending on technology; methodology fairly undefined.
Course Construction	-usually well-established means of creation, production and distribution	-construction can vary greatly
	-low start up costs; (books and lab materials)	-higher start-up costs (production costs of writing materials, design, coordination costs)
Administration (Kaye and Rumble, 1981)	-little administrative support required; problems concerned with scheduling and management of staff within a school	-more administrative support. Attention to production, distribution, technical considerations; may share administrative duties with other administrators; liaison activities
Cost Structure (Kaye and Rumble, 1981)	-labor intensive	-capital intensive
	-directly and primarily related to number of students	-related more to course creation and production costs
	-unit costs do not vary significantly from year to year	-unit costs drop significantly with higher enrollment

Examples of Distance Education and Distance Delivery

The following are examples of institutions and corporations using various distance delivery technologies to reach learners at remote learning sites. These examples were chosen for their diversity in terms of technology and mission. Currently, world-wide there are a number of institutions that are delivering education totally by distance delivery. Many of these are four-year degree-granting institutions. Perhaps the best known is the Open University in the United Kingdom. It serves as a model for many of the other distance education institutions that have formed in recent years. The university had its beginnings in the early 1960s when the then government of Harold Wilson perceived a need to offer education to many who did not have access to it in earlier stages of their life or who were unable to access education at conventional institutions. A charter was granted in 1969 establishing the university as an independent and autonomous institution authorized to confer its own degrees. The university is "open" for several reasons: it is open to everyone regardless of academic qualifications; it is open to innovation; it is open year around, and it has an open campus that includes the entire country. The headquarters of the university is at Milton Keynes and has a staff of 700, including 145 academicians who currently serve 65,000 students. The institution offers undergraduate and graduate degrees in many fields, including most of the sciences and humanities. Courses for students who wish to extend knowledge and skills are also offered through an associate student program that includes courses in community education, in-service teacher training, health and social welfare, technological updating, and management training, as well as undergraduate courses. This apparently will be the growth area for the university in the near future as many students are not interested in pursuing degrees.

The most important element in the instructional system is the printed course materials that students receive weekly. The materials contain instructional materials and assignments which are returned. These printed materials are supplemented by television and radio programs and by tutorial and counseling sessions offered on the weekend by tutors ordering short summer sessions. According to Ural (1982), each of the above mentioned mediums fulfill a specific instructional function--radio motivates, television takes students to places they usually cannot go, kits provide laboratory experiences and texts present verbal and symbolic information. Courses are constructed by course teams consisting of academicians, broadcast producers, instructional design specialists and tutors who represent the human link between the institution and the student. Because of this, courses are multi-disciplinary in nature.

Evaluation is an integral part of the learning process at the university. Students are evaluated on the written work they submit and on examinations at the end of the course. Course work is either graded by tutors or by computer depending on the class. In addition to supplying a grade, computers offer feedback on student comprehension and analysis of the assignment. The final examinations are held at examination centers throughout the country (Holmberg, 1977; Percival and Ellington, 1981; Zigerell, 1984; Ural, 1982).

The open university has been very successful in filling a educational void by offering course and degrees that would not be otherwise available to the

students. The student population is very heterogeneous in nature though the working class occupations and women have been underrepresented. It is interesting to note that the minimum age for enrolling is 21 since it is felt that those younger lack sufficient motivation and maturity to successfully participate in the Open University (Zigerell, 1984). All in all, the British Open University has been and continues to be very successful. It is a pioneer in distance education and serves as a model for institutional organization, distance delivery, and the successful construction of courses and course materials.

Another institution that is often cited in the literature as an example of an institution using distance delivery effectively is Kirkwood Community College, Cedar Rapids, Iowa. The college serves a seven-county area in eastern Iowa that has a population of approximately 350,000. To extend educational opportunities to the residents of the area, Kirkwood established the Kirkwood Telecommunications Systems (KTS). KTS utilizes a variety of interactive services that include a microwave network (Telelink) that interconnects eight locations; Instructional Television Fixed Service (ITFS), with four main channels and six additional channels; a cable network that serves eight communities; a telecommunications control center; specially equipped classrooms located on campus and at the remote sites; a public FM radio station; a satellite downlink; a full color television production facility and a 36-channel on-campus closed-circuit demand access cable system. Future plans include expansion of the microwave network which will carry additional voice and computer data.

Presently the system offers a variety of classes and instruction at the secondary and post-secondary levels. Telelink allows students to enroll in college classes which can be taken at the remote learning sites in their home communities. The interactive portion allows students to interact with students at other remote sites and with students at the main campus. Kirkwood recently graduated a student with a two-year degree who had taken all the required course work via Telelink. Instruction to the secondary schools, inmates at the Iowa Men's Reformatory at Anamosa, courses in professional recertification for nurses, insurance and real estate, and community education classes are offered over the ITFS system. One ITFS channel is also used to interconnect with local cable companies. This allows subscribers to take college credit and community education courses in their own homes. While ITFS is a one-way transmission, interactivity is accomplished by using FM radio-response transmitters at the receiver sites to return an audio signal. In the near future Kirkwood plans to expand the ITFS offerings to include a network that serves the Cedar Rapids school district and a area business and industrial service channel that will serve the training needs of employees in these businesses.

The college also operates full-service educational cable channels in the Cedar Rapids, Iowa City, Mount Vernon and Lisbon areas. The programming originates on campus with a broadcasting day from 7:00 a.m. to 10:00 p.m. A billboard message system airs during the off-time hours. Programs include telecourses for credit and non-credit, live and recorded programs, films, information segments, and satellite programming.

Personal observation of the Kirkwood facilities found a dynamic and committed approach to distance education. The college is apparently meeting the

needs of many through its many interactive and cable offerings. Staff teaching over the system receive special instruction before teaching on the system in the areas of instructional design and technical operation. It is evident that the college has made a tremendous investment in the various components of the system and thus is making a major commitment to the distance delivery of education. It was also evident that KTS because of its multi-phased approach requires a significant number of personnel to run the system. In addition to assistants, engineers and support personnel at the main campus, county coordinators and their assistants are in charge of recruitment, programming and scheduling at the county learning sites. Thus, the entire system is seemingly capital and labor intensive.

Industry has also begun to see the merits and savings of utilizing distance delivery of education. A number of firms have begun to use various technologies in very effective ways to train their staffs and to communicate with management at the various levels. A few industry approaches will be highlighted. Traveler's Insurance Company utilizes teleconferencing as a means of providing sales training nationwide for its many agents. Traditionally, Traveler's would train agents via a conventional setting during a week long session. Beginning in May 1983 Traveler's began experimenting with live interactive telelecture. The format includes typically 1 to 1 1/2 hour tele-conferencing sessions that occur weekly over a three month period. Written programmed materials guide the students through the course with weekly assignments that are to be completed prior to the telelecture. The training classes which have been offered in the securities area culminate in a securities licensing exam. Traveler's reports a 89% success rate in agents passing the exam with the teleconference training as compared to 50% success rate with the conventional approach (Levinson, 1985). These percentages have been constant over the three year period. Tele-training will be expanded into other areas of Traveler's in the near future. Additionally, an IBM-PC computer network hook-up will augment the instruction and provide another interactive means of instruction. The training has been well-received by staff and management alike. Additionally, there have been significant savings both in time and travel and lodging expense (Jake Landry, personal communication, February 12, 1986).

IBM is also utilizing distance delivery as a means of updating and training sales representatives. The IBM system which was put in place in 1984 is an interactive (2 way audio, 1 way video) satellite system. Instructors are located at one of three transmission sites with students being located at any of 9 other centers. Students at remote sites are able to receive two live pictures from the instructional site. A unique aspect of the IBM system is the provision for instant feedback from any or all of the students to the instructor. Each student has a panel of buttons located in front of them. One button is depressed when the student wants to talk to the instructor and the other buttons are used to answer multiple choice questions. A control panel in front of the instructor is used by the instructor to identify the sources of questions. Also, the instructor can use test questions, i.e., multiple choice or true and false, to determine the effectiveness of instruction. Results are tabulated instantaneously on the instructor panel. This gives the instructor feedback and is consequently used to make instructional decisions. The numbers of support personnel are kept at a minimum at the remote sites with sites usually consisting of one coordinator and the necessary clerical support. Currently,

23% of sales training is done on the system with additional receiving sites currently being added. Again, savings in time and other associated training costs are being realized. With a scrambled signal, management interactions are also possible on the system (Maureen Curran, personal communication, February 18, 1986). These are but two of the many industry examples that could be detailed. Others are experimenting with a variety of approaches using various technologies. Teleconferencing and interactive systems seem to be getting a lot of attention. However, video tape, audio tape, computer instruction and programmed learning materials are being used by many of the firms contacted.

A final example of distance education is primarily vocational in nature. Beginning in 1979, vocational courses have been offered over Wisconsin's Technical School of the Air. Through this program, video-based vocational-technical courses are delivered via broadcast and cable television to the general public and to technical institutes and high schools for classroom use. In a two-year period from 1980-1982 over 4,000 off-campus adults along with many students on campus took courses in Basic Electricity and DC Circuits; Basic AC Circuits; Marketing Perspectives-An Introduction to Marketing; and General Educational Development. The program is a cooperative effort between the Wisconsin Board of Vocational, Technical and Adult Education (VTAE), the state post-secondary districts, the VTAE Foundation, with additional support by various government agencies and public television stations. The project has been very cost effective, with savings coming from the elimination of duplication of production, and the ability to serve larger numbers of tuition-paying students, many of whom would not have enrolled in similar campus courses (Brumm, 1982).

One school, Northeast Wisconsin Technical Institute in Green Bay, has made extensive use of the AC-DC circuits TV course by offering a 2 credit TV course for the theory portion of the course which can be taken by students in their own homes. An optional 2 credit hands-on lab is also offered. Students complete the requirements by either attending the lab sections offered during regular school hours or special Saturday sessions. Tests are taken either at the school directly from the instructor or in the school's Information and Assessment Center. Teacher contact is provided for by orientation sessions at the beginning of each course, two-hour review sessions before major tests, or by telephone. Further contact is provided by the mail. The success of the course has been due to the instructor, plus careful preparation of course materials and tests which are designed specifically for off-campus students (Mirkin, 1982). While the hands-on portion of many vocational offerings seem to preclude many vocational education courses from distance delivery, the Northeast Wisconsin Technical Institute has addressed this problem.

Distance education courses offered by Wisconsin Vocational, Technical and Adult Education Districts have been expanded to include courses in communications, sociology, math, personal finance, human relations, management, computers, law, and child development. In addition to using broadcast and cable television technologies, interactive video, radio, telephone conferencing and news paper are also utilized (Sandra Carman, Personal Communication, August 12, 1986).

As can be seen, distance education takes many forms depending on the technologies, the educational institution, the nature of the material and available financial resources.

CHAPTER II

DISTANCE DELIVERY TECHNOLOGIES

In this chapter, the various distance delivery technologies utilized in distance education are described with the exception of interactive television which will be discussed in the next chapter. Table 1 in Chapter I categorizes the various distance delivery technologies discussed here. Matrix 1 at the end of the chapter deals with the pedagogical and management factors associated with the technologies. The following discussion elaborates on each of the components listed in Matrix 1 and can be used as a quick summary reference.

Print Materials

Printed materials are the most frequently used medium of distance education and as previously indicated play a central role in distance education. These materials may be the primary means of instruction or used in conjunction with other distance delivery technologies such as audio cassette tapes, broadcasts and video cassettes. Referring to Figure I, the importance of the printed materials as the primary source of instruction decreases as one proceeds from Type II, where printed materials are the major means of instruction, to Type VI, where printed materials may be used supplementally or not at all. Printed course materials include primary materials such as texts, lessons and study guides, or supplemental materials such as notes, assignments, drawings, journal articles, bibliographies and the like (Holmberg, 1977; Kaye and Rumble, 1981; Zigerell, 1984).

As with printed materials used in the conventional classroom, printed materials used with distance education need to be intelligible and interesting to the students. Holmberg (1977) points out that the materials should be well structured, cohesive, relevant, stimulating and readable with understandable sentence structure and vocabulary. In addition, style layout and eye appeal are of particular importance to the distance learner who is studying individually or in a group setting at a remote site. The materials also must be designed to motivate the student and to reinforce learning (Kaye and Rumble, 1981). Motivation can be aided by the use of deadlines, scheduling of the teleconference calls, or radio and television broadcasts, for example. The use of questions and answers throughout the material would aid reinforcement.

Since many of the student learners could be adults, course materials will need to be designed with the adult learner in mind. According to the literature, adults usually have many experiences to draw upon, are goal seeking

and tend to be now oriented. Furthermore, adults are motivated by their life and career stages (Hough, 1984; Kaye and Rumble, 1981; Holmberg, 1977; Zigerell, 1984). Consequently, these factors will need to be considered when designing the courses and materials.

Printed materials place a couple of limits on the learner. First, with printed materials, students need a fairly high level of literacy skill to read and utilize the materials properly. This could be a problem for certain learners. Secondly, by their nature, printed materials tend to impose a linear learning strategy on the student (Kaye and Rumble, 1981). Efforts would need to be made to assist the student in seeing the whole picture and in branching or obtaining additional information or remediation.

The design and construction of printed materials would no doubt become a team effort. Because of these many considerations, individual instructors would work with other subject matter experts, instructional technologists, editors, design and layout people and printers to produce sound and accurate written materials. While the necessity for and the composition of the contributors in formulating the materials would vary as to subject matter, technology employed and the level of student-teacher interactivity taking place during instruction, it would be a cooperative effort underscoring the changing role of the distance instructor.

Because of these special considerations, and the lack of printed course-specific distance education materials, one would expect the materials to be more expensive. Frequent revisions of materials in high change areas would also be an additional cost factor (Marion Baron, Personal Communication, March 5, 1986; Kaye and Rumble, 1981). However, the print medium when compared with broadcasts, interactive video and other media is relatively inexpensive. Widespread use would also bring down the per unit cost (Crooks, 1983).

Laboratory kits also fall into the category of printed materials. These kits will be used with some courses to supply the laboratory and hands-on requirements. The kits could be used in the home, in the field, and could incorporate the use of microcomputers. As an example, the electronics department at Northeast Metro Technical Institute, White Bear Lake, Minnesota, uses laboratory kits in an individualized electronics program that serves Northwestern Bell employees learning independently at remote sites in a four-state area (Fred Boggs, Personal Communication, February 25, 1986). Students complete the assigned laboratory tasks in conjunction with the printed lesson materials. Proctored tests are then taken over laboratory portions of the course. Telephone assistance is provided by having subject matter experts available for students who can call on a toll-free number. Thus, students benefit both from written instruction and the ability to apply learned skills in a guided hands-on setting.

The preparation of laboratory kits include many of the same considerations and factors that go into producing printed materials. Additionally, care must be taken to integrate the laboratory activity with the printed course materials and to provide all the steps necessary to carry out the laboratory activity. Limiting factors to the incorporation of laboratory kits include safety, and access to and cost of the equipment and materials (Kaye and Rumble, 1981).

In summary, print materials and laboratory kits require special care in their development, design and useage. While the relative importance of these materials varies across the types of distance education, they are none-the-less an integral part of the instructional process.

Audio Technologies

Audio technologies form a second group of technologies that are utilized in distance education. These older technologies have been used in distance delivery for many years and include audio cassette tape, radio, and telephone technologies. Recent changes in technology and in the operating costs are renewing interest in these technologies and may lead to an expansion of their use.

Audio tapes usually in the form of cassettes are a familiar technology that are widely used both inside and outside of education. With the rapid development of the interactive technologies, audio cassette tapes are often overlooked. In comparison with the various television technologies and interactive video, audio cassette tapes offer a number of advantages that include inexpensive production costs in terms of recording equipment, tapes and duplication, inexpensive play-back equipment, control of the learner over the scheduling and use of the tapes, replay advantages, and the ease of use by learner and instructor alike. Audio cassette tapes can be used by educators for a variety of purposes that include instruction and the teaching of a variety of topics, guiding experiments and lab activities, and providing instructions for a variety of situations.

Audio cassette tapes can be designed for a variety of learner responses that include instances where the student is passive, such as listening to a lecture, or where interaction is provided for by having the student answer questions or exercises at certain intervals throughout the tape. This interactivity would be in conjunction with written materials accompanying the tape. The degree of interactivity would then be determined by these written materials and by the nature of the course. Laaser (1986) classifies the use of audio cassette tapes into eight categories. Category one is a recorded lecture that the student listens to with little active involvement. Category two includes periodic summarization comments by the instructor or other narrators. These comments may be made as responses to questions in the printed materials or as comments to facilitate understanding of the unit of instruction. Category three includes a discussion between the instructor and others such as subject matter experts. Category four is an interview of a subject matter expert by the instructor or some other person. Categories five and six expand the interview to include a number of experts with divergent opinions (category five) and to take these mini-interviews on location, thus building on environmental sounds as part of the process (category six). Category seven includes documentaries that have been prepared for other media such as radio or television and have been recorded on the audio-tape format. Finally, category eight includes role-playing and dramatization of the subject matter. Clearly, each of these categories would necessitate different production approaches and their use would be dictated by the content of the course.

All in all, audio cassette tape is a low cost distance delivery technology that is often overlooked. Because of widespread familiarity of the use of audio

cassette tapes, it is a technology that could be easily used to deliver certain distance education courses.

Radio offers another means of audio distance delivery. Radio plays an important role in distance education both here and abroad (Crooks, 1983; Purdy, 1983). The use of radio in this country for educational purposes began in the early 1920s with many colleges and universities organizing radio stations on campus to meet both formal and informal education needs. Interest in the use of radio has varied, and while television often overshadows radio, it still remains a viable alternative for distance education. Radio classes can be broadcast over the traditional AM and FM stations or over Subsidiary Communications Authorization (SCA) bands to serve specific target audiences such as the handicapped, off-campus students and professional groups such as doctors and nurses. Radio offers a low cost means of production, distribution, transmission and reception especially when compared to television. It can be especially effective when combined with appropriate print materials. Radio can also be interactive by the use of two-way radio transmission and/or a return to the originator via the telephone. Thus, while radio does not usually receive much attention, it has and will continue to be an important distance delivery medium.

A third means of audio distance delivery is the telephone. While this technology has been fairly widely used in the past for educational purposes, the telephone is being considered with renewed interest. This is due, in part, to technological developments which have lead to better and alternative routes of transmission and to regulatory developments which have opened up the market place (Baig, 1986; University of Wisconsin, 1985). Interest by educators is being paralleled by an increased interest by industry trainers who look at the various telephone technologies as a means of saving time and money.

The telephone can be used in a variety of ways for both audio and video transmission. Video (audio-graphic) transmission will be summarized later in this study. The telephone can provide one-on-one interaction, such as the use of toll-free numbers for individual student conferencing and assistance, or it can be used to interconnect groups of individuals or groups with instructors and speakers at remote sites via teleconference. Teleconferencing is accomplished using a multi-line interconnection device called a bridge to which the users via regular, dedicated and local or long-distance lines can connect handsets, speaker phones, headsets or microphone speaker units. The bridges can be end-line bridges owned by educational institutions that can be operated by the instructor, a centralized bridge that is fully automatic and owned by the telephone company or conference-operator bridges where the telephone company conference operator schedules the conference and calls each location manually.

As a means of instruction, teleconferencing should be thought of as an integrated package that includes the instructor, printed materials, visuals, telephone technology, and support staff such as coordinators that may be involved. Careful preparation of both the course materials and the instructors involved are essential (Levinson, 1985; Robertson, 1984). Advantages to teleconferencing include its widespread availability, acceptance, ease of use and adaptability. Pedagogically, teleconferencing provides live, voice-only audio interaction between the learners and the instructor, is instructor directed and controlled and can easily be enhanced by other technologies such

as the audio-graphic or prepared video tapes which add an additional dimension to the instruction. Administratively, teleconferencing can save time and travel expenses and can expedite inter-instructional communication.

Perhaps the best example of an educational institution utilizing teleconferencing for distance delivery is the University of Wisconsin which began using teleconferencing in 1962. Since that time the university has created several networks with which to meet the educational needs of various and diverse groups throughout the state. These networks include the Educational Telephone Network, a dedicated network which delivers credit, continuing education and public service programs; the Statewide Extension Education Network which delivers graphics in addition to the audio; an administrative teleconference network; and a dial-access service which gives the caller an opportunity to listen to audio cassette tapes on a variety of topics. Currently, the university is assessing alternative methods of delivery (Reid and Champness, 1983; University of Wisconsin, 1985).

In summary, the use of the telephone is an important distance delivery technology. It is a technology that is commonplace, versatile and one that offers an inexpensive way for distance learners to access educational offerings and opportunities.

Audio Graphic

Akin to the telephone technologies are the audio-graphic technologies. Of these technologies identified as audio-graphic in Table 1, the electronic blackboard and the facsimilie will be discussed briefly here. Slow-scan and compressed video will be considered with the interactive technologies discussed in the next chapter. These audio-graphic technologies can be used in conjunction with interactive audio and are usually transmitted parallel to the sound. The electronic blackboard uses a digital blackboard that converts the chalk lines to an electronic signal which is then transmitted to the remote site(s). The signal is then shown on a television monitor. The electronic blackboard is especially effective in classes which deal with theory, formulas and mathematical computations, and line drawings. Facsimilie transmission, on the other hand provides for electronic transmission of hard copy such as typewritten materials, drawings or computer print-outs to remote sites. An optical scanner converts the print and nonprint areas of the page to electronic signals that are transmitted to the remote site where they are converted back to the original image and are printed on hard copy. These copies then can be duplicated for dissemination to the students. Thus, by using these technologies an added dimension of interactivity can be attained.

Full-Motion Video

The next category listed on Table 1 is the full-motion video technologies. Of those listed, broadcast television, videotapes and interactive videodiscs will be discussed here. The remaining technologies commonly used with interactive television systems will be discussed in the next chapter.

Broadcast television, i.e., broadcasting signals on assigned carrier waves, is a technology that has been used for a number of years for educational

purposes. With the advent of the medium in the late 1940s many educators viewed television as a tremendous opportunity to increase course offerings and to revolutionize education. What occurred was a widespread acceptance and utilization in the 1950s that turned to disillusionment in the 1960s. Broadcast television did recover somewhat in the 1970s and today is used very effectively by a number of institutions (Zigerell, 1984). Broadcast television is used typically to deliver specifically designed programming for instructional purposes to target groups of students which may include professionals enrolled in continuing education courses and students enrolled in degree and nondegree courses. Programming for these courses may be designed specifically for instructional purposes or may be wraparound programs where instructional materials are prepared for programming that is not specifically designed for formal educational purposes (Purdy, 1983).

Broadcast television offers the advantages of being able to reach potentially large numbers of people in a given geographical area with live or pre-recorded programming on relatively inexpensive receivers. Additionally, television can go places where students ordinarily would be unable to go. Despite these advantages there are some serious disadvantages that limit broadcast television's effectiveness. Lack of interactivity, available channels, specific programming, and the high costs of equipping the studio and producing the programming are obstacles to widespread utilization of broadcast television.

There are a number of educational institutions that use broadcast television. Two will be briefly mentioned here. Chicago's TV college has been offering televised credit courses for twenty-five years. Programs are broadcast over a UHF station owned and operated by City College of Chicago, thereby allowing students to receive college instruction in their homes. A few students elect to complete their two-year degrees via television while many begin with televised courses and then opt to continue with traditional courses (Zigerell, 1984). A second example is Coastline Community College in California. Coastline offers 20 open broadcast courses over the college-owned television station. These courses account for 20% of the 25,000 student enrollment (Ural, 1982). In summary, broadcast television, despite some major disadvantages, does offer a means of distance education delivery that can be very effective in certain settings. Perhaps the most widespread use could come from wraparound courses.

Video tapes as a means of distance delivery are getting much attention today. With the proliferation of video tape players and recorders in the home and in industry as well as in school, and with the decreasing per unit cost and increasing quality, this means of educational delivery is becoming widely used. The applications to both distance and conventional education are many. Video tapes can be used to perform taping on location, provide instant feedback, tape interviews, preserve information and dispense information quickly and easily. Additionally, video tapes are versatile in that they are easily transported, edited, reusable and allow the use of graphics (Voland, 1984). With camera and recording equipment becoming commonplace, reasonably good quality tapes can be produced by novices using ordinary, nontechnical equipment.

As a means of distance delivery, well-designed video tapes can be used individually or in group settings to offer the learner a greater amount of

flexibility in that tapes can be stopped, replayed or fast-forwarded depending on the student need. This is an important factor in the design of the course material since it allows learner interactions with the tape. The use of questions for understanding and motivation can become part of the materials. Students then can turn off the tape while answering questions or completing assignments on the printed materials. Answers and explanations are prerecorded on the tape and give the student feedback and further explanations (Zuber-Skerritt, 1984). Live interactivity also can be easily provided by using toll-free numbers or teleconferencing.

As with other technologies, there are a few drawbacks with video tapes. Good quality videos take time to design and produce and, depending on the nature of the material, may be expensive to produce initially. Printed materials that may be needed will also add to the initial expense because of the time needed to produce good quality materials. Secondly, the content may become out-of-date technologically or style-wise in a short period of time. This will necessitate updating and in the case of technological updating will necessitate revision of printed materials. Thirdly, video tapes will magnify instructor disorganization, annoying mannerisms, and the like (Zuber-Skerritt, 1984). Finally, not all video tape equipment is standard or of the same quality. Besides differences in tape size, there is also incompatability between certain formats and machines that must be considered.

In summary, video-tapes offer much promise for distance education. Low cost, ease of use and production, versatility and commonality make this technology an attractive one to use.

A rapidly emerging full-motion video technology is the interactive video disc. Interactive disc systems are typically comprised of 12 inch thin metal discs that store laser-etched information on their surfaces, a video disc player that reads the disc by laser beam, a monitor that displays the information, and a microprocessor or a microcomputer with associated software that is the heart of the system and allows the user to interact with the system. There are three different levels of interactive video-disc systems. Level one uses a video-disc or video-tape player and presents information in a linear fashion. Interactivity is very limited. An example would be discs distributed by College U.S.A. which present information about various higher learning institutions. Level two hardware includes a video-disc player with a microprocessor. Memory is limited. Programs can be branched and can include menus, review paths and provisions for testing. Level three utilizes a microcomputer such as an IBM-PC and a special monitor which allows for linear instruction, branching and record keeping. Hardware integrating all the components into one unit is also available (Len Mrachek, personal interview, May 28, 1986).

Because of the associated components, the system can perform in some very sophisticated ways. The disc which stores up to 54,000 individual frames of information per side can be used to store immense amounts of still-frame information or it can store full motion video. The laser technologies enhance the quality of the video and audio and the long-term usability of the disc. The computer or processor allows the user to interact and to obtain feedback with the disc with many simulations approaching realistic conversations and quick random access to any of the individual frames of information. Finally,

the material can be branched which allows for flexibility and remediation and enhances its versatility (Clark, 1984).

There are a number of advantages to video disc in addition to the capabilities mentioned above. Its versatility allows for a variety of formats within one program. For example, still frames of information, line drawings, and motion can be incorporated together. This variety enhances learner motivation and understanding and decreases the amount of time required to learn a given topic. The ability of the equipment to freeze frame and to use frame-by-frame progressions are also important advantages and allow learners to proceed at their own pace and to control the learning situation. The laser technology permits a disc to be reused repeatedly without loss of quality. Finally, discs are reproduced inexpensively (Bosco, 1984; Copeland, 1983; Duke, 1983; Laurillard, 1984).

The major disadvantages of video discs are cost, availability of courseware, the amount of hardware equipment needed and the difficulty in updating and/or revising materials on the disc. Currently, the cost for hardware for an individual interactive system ranges from under $1,000 for level one hardware to upwards of $10,000 for integrated units (Bosco, 1984; Clark, 1984). It is estimated that this cost will drop with widespread use. Software costs vary with some individual discs costing $2,000 and up. The number of discs needed per course vary depending on the nature of the material and the format. With continuous full-motion video, a disc provides about 30 minutes of instruction. However, with interactivity and a variety in information presentation, this could potentially be extended to eight hours per side (Duke, 1983). A larger problem is the lack of available software, which is a result of the newness of the technology and the high developmental costs, which range from $3,500 to $10,000 per linear minute (Price and Marsh, 1983). Because of the interactivity, branching, inclusion of still frames and motion, a tremendous amount of programming time is needed to produce a single disc. Thus, with uncertain demand, many companies have yet to begin producing software on a large scale which would ultimately bring the price down. However, with increased demand plus technological advances in the hardware, especially the recording ability, the use of video-discs may soon become widespread.

Interactive video discs have a number of very enthusiastic supporters. Initial successes, in particular with the military, indicate that interactive video discs can reduce learning time, increase retention and offer training simulations that would not ordinarily be available (Hon, 1983). Enthusiasts envision video discs reshaping the whole of education and radically changing traditional education (Price and Marsh, 1983; Wilson, 1983). Currently, a number of post-secondary vocational institutions in the state are using interactive video discs to assist students in updating their mathematical skills and competencies.

While the above discussion was confined to interactive video disc it should be noted that similar systems using random access video-tape machines are also available. While these machines are limited in their flexibility they do allow for a certain amount of branching. These systems are relatively inexpensive, convenient and do allow for interactivity. However, random access is slow, and

the slow-motion and stop-frame options are limited. Based on these limitations and especially in light of the video-disc capabilities, little development will probably take place with this technology (Duke, 1983). It should be noted, however, that interactive-video tape courses are currently being marketed by the Wisconsin Foundation for Vocational, Technical and Adult Education, Inc. (VTAE) with a high degree of success. Plans are to continue with these offerings until sufficient demand is generated to warrant the development of interactive video disc formats (Sandra Carman, Personal Communication, August 12, 1986).

In summary, interactive video disc offers a sophisticated high-tech option for distance education. While there are many advantages of this technology, the costs, available courseware, and amount of hardware needed seem to present an obstacle to widespread adaptation.

Computers

The final category on Table 1 is the computers. Mainframe, mini- and microcomputers can be used in distance education to provide computer-assisted instruction, computer managed instruction, computer conferencing, and information services such as videotex. Each of these options will be discussed below. While computers have been around for sometime, the recent widespread distribution, especially of the microcomputers, and the changes in communications technology make computers a realistic distance delivery technology (Kaufmann, 1984).

Computer-assisted instruction (CAI) directly involves the computer in presenting instruction to the student in an interactive manner. The programmed and package courseware instructs by drill-and-practice, simulation, gaming, tutorial, and problem solving. CAI allows for interactivity and student involvement, immediate feedback, and has the potential for self-paced learning and remediation. One of the drawbacks to CAI is the lack of software for many program areas (Burge, Wilson and Mehler, 1984). PLATO and TICCIT are two systems that have been developed and widely used.

Computer-managed instruction (CMI), which uses the same hardware as CAI, provides instructional management functions that include organizing curricula, maintaining student records, monitoring student progress, diagnosing and accessing student needs, scoring tests and the like. With these capabilities, CMI can provide useful information to students, instructors, and instructional designers for use in assessment, grading and planning. A number of distance education institutions use CMI quite effectively (Percival and Ellington, 1981).

Computer conferencing is a system which enables two or more individuals at different locations to communicate directly by using keyboard terminals, printers, and telephone lines to access common computers. Students can communicate with the computer, the instructors and other students directly or via stored messages that are available at anytime. In addition to instruction and intercommunication, students can complete assignments and receive grades via the system. The advantages of computer conferencing include learner control over time and distance, feedback from multiple sources, the ability to interact with others including subject matter experts, the fostering of deeper contemplation as a result of encoding messages, and the ability to reach large

numbers of students with the same messages. A number of institutions are currently using computer conferencing as a means of distance delivery. These include the Western Behavioral Sciences Institute in LaJolla, California, the New York Institute of Technology, and several Canadian Institutions (Burge, Wilson and Mehler, 1984; Cross, 1983; Haile and Richards, 1984). Computer conferencing can also be used effectively for professional updating. High school physics teachers in Iowa, for example, are updated in their own school laboratories by periodic conferencing with a University of Iowa professor (Braun, 1984).

The last computer technology to be discussed is videotex. Videotex is a generic term for systems that provide computer-based services that include the storage, processing and transmission of data (Hurly, Laucht and Hlynka, 1985). These systems are user friendly and use microcomputers or computer terminals to communicate with mainframe computers via a variety of carriers such as coaxial cable, fiberoptics, or satellite and radio signals. These systems can be used to obtain information such as weather and market reports; for entertainment; to conduct business transactions; electronic mail; or for educational purposes such as the above mentioned computer conferencing.

There are three types of videotex. Viewdata is a fully interactive videotex where the user makes selections from main menus and then requests and receives services from the centralized computer. Teletext is a generic term for broadcast videotex services. The computer is connected to a television broadcast system which transmits the information over the air or cable to the television screen of the user. The user selects from the broadcast schedule rather than interacting directly with the computer. The third videotex option is open-channel teletext. Information over this form is exemplified by all-weather or sports channels on cable television, arrival/departure displays at airports, or as open and closed captioning on television broadcasts (Hurly, Laucht and Hlynka, 1985).

In summary, computer options for distance education are varied. While the hardware is affordable and commonplace in schools, business and in many homes, the major limitation is software. As software is developed, this option will be utilized more fully.

Summary

As can be seen, there are a variety of technologies which may be used to deliver instruction to students in a variety of settings. These technologies vary in terms of sophistication, cost, adaptability, and versatility with each having its own particular set of advantages and disadvantages. Many of these technologies are or can be used in conjuction with each other. For a comprehensive, detailed description of how these technologies are currently being used in Minnesota, the reader is referred to the Minnesota Higher Educational Coordinating Board report Information Technologies for Instruction in Minnesota Post-Secondary Institutions (Honetschlager, 1986).

As a means of comparison and summarization, the following matrix (Matrix 1) presents the above mentioned technologies in one dimension and general, learner, teacher and pedagogical considerations in the other dimension. While the list

of considerations is not exhaustive, it does serve to illustrate the differences between the technologies and their application to different educational settings. Because of the newness of technologies such as interactive videodiscs, certain cells are empty.

Matrix 1

General, Learner, Teacher and Pedagogical Considerations

	GENERAL CONSIDERATIONS			LEARNER CONSIDERATIONS		
	Technology	Primary Use(s)	Target Audience	Student Cost	Motivation Factors	Acceptance Factors
PRINT	Printed Materials	1. Primary means of instruction. 2. Supplemental materials	Adult; Non-traditional student.	Minimal	1. Personality (self-motivation/ maturity 2. Previous experience 3. Reading and learning skills. 4. Fits personal schedule.	1. Readability 2. Equivalency to convention. 3. Access to instruction assistant.
	Lab Kits	1. Provide hands-on on experience.	Adult; Non-traditional student.	Depends on the nature of activity; could necessitate access to a personal computer for example.	Same as above	1. Clarity 2. Access to instructor/ assistant
AUDIO	Audio-Cassette Tapes	1. Primary means of instruction-content. 2. Supplemental means of instruction. 3. Means of interactivity provide direction, feedback	Adult; Non-traditional student.	Minimal	1. Personality factors. 2. Previous experience 3. Fits personal schedule. 4. Course construction that includes regular assignments.	1. Format 2. Supplementary materials. 3. Access to assistance. 4. Equivalency
	Radio	1. Provide instruction. 2. Provide motivation and means contact and identification with the institutions.	Adult; Non-traditional	Minimal	Same as above.	Same as above.
	Telecon-ferencing	1. Instruction 2. Discussion 3. Problem solving 4. Administrative purposes	Adult Non-traditional student	Minimal Long distance charges.	1. Personality factors. 2. Previous experience. 3. Fits personal sequence. 4. Course construction that includes regular assignments. 5. Format and pacing of the course.	1. Format 2. Quality supplementary materials.
	Dial Access	1. One-to-one contact with student.	Can be used in a variety of settings for assistance and information.	Minimal	1. Toll-free numbers. 2. Convenience	1. Quality of assistance 2. Availability of content.
AUDIO-GRAPHIC	Electronic Blackboard	Provide visual content. 2. May be used as an interactive device.	Adult Technical offerings; some application to post-high settings.	Minimal	1. Personality factors. 2. Previous experience. 3. Availability.	Instructor utilization.

Matrix 1 - continued

		GENERAL CONSIDERATIONS		LEARNER CONSIDERATIONS		
		Primary Use(s)	Target Audience	Student Cost	Motivation Factors	Acceptance Factors
	Compressed Video	Provide interactivity		Minimal		Slight transmission delay of Video.
	Facsimile	Transmit data.	Can be used in a variety of organizational settings.	Minimal	Not applicable.	Not applicable.
FULL MOTION VIDEO	Interactivity Television	To provide full	Secondary; Post-	Minimal	1. Personality factors.	1. Quality of transmission 2. Friendliness of hardware 3. Convenience 4. Orientation 5. Instructor utilization
	Video Tape	Provide primary or supplemental instruction.	Supplemental to secondary and post-secondary; Adult and non-traditional students.	Access to video player.	1. Personality factors. 2. Previous expense.	1. Currency 2. Quality 3. Variety
	Interactive Video Disc	Provide primary instruction.	Secondary; Post-secondary; Adult	Minimal assuming hardware and software is provided by institution.	1. Personality factors	1. User friendliness of hardware and software 2. Quality of materials 3. Proper orientation and 4. Format of the material 5. Up-to-date materials
COMPUTER		Provide instruction. Provide interaction. Computer managed instruction;	Secondary; Post-secondary;	Access to microcomputer. Transmission costs.		Same as above.

Matrix 1 - continued

TEACHER CONSIDERATIONS

		User Friendly	Preparation Time	Coordination With Other Professionals	Training Needed	Flexibility
PRINT	Printed Materials	Yes	Initially-much Revisions-little to moderate	Very necessary	Moderate	Little in the short term
	Lab Kits	Somewhat dependent on associated hardware	Same as above	Somewhat necessary	Moderate	Somewhat
AUDIO	Cassette Tapes	Yes	About same as conventional classroom	Somewhat necessary	Moderate	Yes
	Radio	Yes	Slightly more than conventional classroom situation	Somewhat necessary	Moderate	Somewhat restricted
	Teleconferencing	Yes	Similar to classroom situation	Somewhat necessary	Moderate	Yes
	Dial Access	Yes	Little	Very little	None	Yes
AUDIO-GRAPHIC	Electronic Blackboard	Yes	Little	Very little	Little	Yes within limits of the technology
	Facsimile	Yes	Little	Very little	None	None
FULL MOTION VIDEO	Interactive Television	Yes	Slightly more than conventional classroom. Greater need to plan detail and on-task activities.	Very little	Moderate	Yes, within limits of the technology.
	Video Tape	Yes	Slightly more than commercial	Somewhat	Little to moderate	Somewhat restricted
	Interactive Video Disc	Yes	Little	Very little	Little to moderate	Limited
COMPUTER		Yes	Equivalent to conventional (Excluding Software development)	Little	Depending on nature of involvement. Moderate to extensive.	Moderate to limited

Matrix 1 - continued

PEDAGOGICAL CONSIDERATIONS

		Nature of Interaction Student/Teacher	Teaching Activities	Feedback	Inducting Transfer	Assessing Attainments (Technology in and of itself.)
PRINT	Printed Materials Lab Kits	Confined to mailings.	Limited to printed materials.	Delayed	Yes	Yes
AUDIO	Audio-Cassette Tapes	Limited to return correspondence via tapes.	Lecture, Panel of experts, Interviews, Instructions.	Delayed	Limited	No
	Radio	None	Lecture, Panel of experts, Interviews. Allows pacing the student activity.	None	Limited	No
	Teleconferencing	Two-way audio.	Lecture, Discussion, Addressing Problems.	Immediate; confined to audio.	Yes	Limited to audio feedback.
	Dial Access	Two-way audio.	Discussion, Addressing Problems.	Immediate; confined to audio.	Yes	Limited to audio feedback.
AUDIO-GRAPHIC	Electronic Blackboard	One-way video; can be two-way with return equipment.		Immediate; with return. Immediate with audio hook-up.	Yes	Limited.
	Facsimile	Confined to print interaction	Limited to transmission of data.	Delayed confined to print correspondence.	Not applicable	Yes
FULL MOTION VIDEO	Interactive Television	Approximated face-to-face.	Variety of activities, Hands on instruction, labs restricted.	Immediate	Yes	Yes
	Video Tape	Limited	Lecture, tutorials.	None	Limited	No
	Interactive Video Disc	Limited	Lectures, tutorials, simulations.	Immediate; confined confined to feedback from program.		Yes
COMPUTER		Limited depending on the situation.		Immediate; Immediate delayed with computer conferencing.		Yes

CHAPTER III

INTERACTIVE TELEVISION

Because interactive television is currently receiving much attention as a means of delivering instruction within the state and nationwide, the technologies that are usually employed are discussed separately below, with Matrix 2 comparing and contrasting the various interactive television technologies. As a means of distance delivery of education, interactive television offers the advantage of immediate audio and video feedback often over significant geographical distances. Many secondary schools especially in the rural areas, have or are forming interactive networks between themselves, with many local post-secondary institutions also becoming involved. The impetus for this comes from the need to maintain or improve educational offerings in the face of declining revenues and declining enrollments. For the most part education via interactive television is well-received by students and staff alike. It does not appear that vocational educators have as of yet become actively involved either at the secondary or post-secondary levels in using interactive television to any great degree.

Of the technologies presented in this matrix, microwave and cable are widely used. Satellite is used spontaneously for special activities on a receive basis only. The major exception to this is the state of Alaska and its Learn Alaska Network that uses satellite as one of the major means of delivery of one-way video and audio with interactivity being provided by other technologies. It should be noted, however, that due to the current oil price situation, satellite delivery of education is being cut back on this system sharply. The network has been reduced to transponders and one channel because of the high cost. Satellite delivery is being replaced by audio and audio-graphic technologies that include electronic blackboards, slow-scan and facsimilie by adding additional telephone lines to the system (Telecoms, June 1986). While full-motion is the preferred choice for interactive television the audio-graphic technologies of slow-scan and compressed video offer possibilities, especially for highly motivated audiences. While these technologies are not fully interactive (though compressed video comes reasonably close), they do offer a means of visual communication of the instructor or support materials using the conventional telephone system. Improvements in slow-scan and developments in compressed video offer some potential. At present compressed video is very expensive.

Because of the interest in interactivity technologies, they are presented on this matrix. The information is presented in relatively nontechnical terms

and is presented as an indication of characteristics and conditions that exist at present. The reader should be aware that rapid changes in both the technologies and their associated costs are taking place. The technologies included in this matrix are as follows:

- Low power television. This is a broadcast medium that is similar to commercial television except that it is limited in broadcast coverage area by its low power signal.

- Instructional Television Fixed Services (ITFS). ITFS is an ultra-high (microwave) frequency broadcast medium that is again similar to commercial television.

- FM microwave radio. This is another ultra-high frequency that is often used to provide the return link in fully interactive systems (simplex). It can also be used in duplex to provide two-way full-motion video and audio interactivity.

- Short Haul FM microwave radio is similar to FM microwave radio except that it is at a higher frequency.

- Cable. This technology uses coaxial cable to transmit programs. Cable companies provide the service in most cases.

- Fiber optics. This is a rapidly developing and emerging technology that transmits voice, video and data by sending light impulses through ultra-thin glass fibers.

- Satellite. This technology uses a device in orbit that travels 22,300 miles above the earth to transmit voice, video or data to locations that can be spread over wide geographic distances.

- Compressed video. This technology which is still in the developmental stages transmits a video signal that approaches full motion. The video signals are sent via fiber optics, microwave or over T.V. carriers. The audio portion is sent over voice grade circuits.

- Slow Scan. These systems use transmitters that scan selected frames and transmit the visual information over telephone lines to receiving sites where the information is reconstituted as a still picture.

The above technologies provide an electronic highway or conduit that allows for video and audio signals to be transmitted from site to site and potentially back again.

There are a number of characteristics that should be taken into consideration when comparing these technologies. These characteristics form the second dimension of the matrix. The characteristics identified are by no means inclusive but were chosen based on information available and as an attempt at finding characteristics common to somewhat divergent technologies. In addressing the characteristics, technologies were considered in and of themselves rather than in combinations with other technologies. While most of the characteristics are self-explanatory, a number needs some qualifications.

When discussing the necessary transmission and receiving equipment, the assumption is made that a classroom(s) with the necessary production equipment such as cameras is provided. Therefore, the classroom(s) and classroom equipment and their associated costs does not appear on the matrix. It is also assumed that the classroom instructor will be able to operate the equipment without help from additional personnel.

Level of interactivity is defined in terms of the interactivity capability of the medium itself. For example, ITFS is described as a one-way audio and full motion video technology while coaxial cable is presented as a two-way interactive technology.

With systems capabilities, an attempt is made to determine the number of individual classes that can occur with the technology per time period. For example low-power television can only air one class per time frame. This one class can be received at multiple sites however. By contrast, a 16 channel optical fiber potentially allows for a number of different classes to be offered simultaneously.

Cost presents a particular problem since there are a number of variables to consider. Initial costs depend on a number of factors that include choice of vendor, sophistication of equipment, availability of technology that is in place (such as a cable system franchise), topographical and distance factors, the network configuration, and the number of users. Consulting fees also vary with the firm and are dependent on the number of sites under consideration. Incidental fees such as attorney and license fees are not identified.

Equipment life is thought of as a long-term cost factor which in this case is defined in terms of use. The rapid technological changes indicated above may make the equipment used by the various technologies obsolete in a relatively short period of time. However, this is extremely difficult to predict.

Matrix 2

Technologies Costs, Advantages and Limitations

Technologies	Transmission Medium and Type	Coverage Pattern	Coverage Range	Transmission Equipment	Receive Equipment	Level of Interactivity Video-Audio-Data (This Medium only)	System Capabilities i.e. number of courses, etc.	Expansion Capabilities
Cable System AM	Bonded Medium Coaxial Cable Commercial Signal Format AM-Video FM-Audio	Point to Point Point to Multi-Point (Depends on cable plan)	Up to 30 miles (Depends on cable size; cable system design)	Modular at each site Remodulators at Hub	Standard commercial or cable ready television receiver	Full interactivity (Limited by number of channels on cable, Data needs different channel)	Depends on channel capabilities	None
Fiberoptics System	Bounded Medium Optical Fiber FM-Video FM-Audio	Point to Point Pint to Multi-Point	Up to 20 miles without repeaters; much further with repeaters (Depends on number of channels and desired signal noise)	FM Modulators and demodulators at each site with optical transmitter and receivers	Monitor; specialized receivers	Two-way audio and video	Depends on channel capability Limited to 16 channels per fiber per direction. Could have 8 two room sessions at one time.	Multiple audio capabilities data
Satellite	Radio (Free Space) FM-Video FM-Audio	Omni-directional Semi-directional	Continental	FM transmitters and large expensive dishes for uplinking	Commercial television receiver in conjunction with T.V. receiver equipment receive disk.	One-way audio and video; Two-way with uplink at both sites.	Limited due to cost.	Additional audio channels (Would have time delays.)
Compressed Video (Digital)	Bonded free space rate. Telephone T_1 carrier, fiberoptics, microwave. (Requires expensive analog to digital conversion.) Digital transmission	Point to Point Point to Multi-point	Limited to wired network.	Analog to digital converter. For one-way video-one channel per T_1 carrier audio-one channel per voice grade circuit. For two-way video-one additional channel per T_1 carrier. Audio-one additional channel per voice grade circuit	Standard television monitor digital to analog converter	Two-way audio-video	None	None
Slow Scan	Voice grade television circuits analog carrier.	Point to Point Point to Multi-point	Long distance (Limited to public switching network).	Slow scan converter for one-way video--one channel per voice grade circuit	Standard	Two-way	Limited to	None

Matrix 2 - continued

Technologies	Transmission Medium and Type	Coverage Pattern	Coverage Range	Transmission Equipment	Receive Equipment	Level of Interactivity Video-Audio Data (This Medium only.)	I.e. # of courses, etc.	Expansion Capabilities
Low Power Television (LPTV)	Radio waves (free space) AM-Video FM-Audio Compatible with commercial formation does not require expensive equipment at receiving ends.	Omni-directional within a small given local.	Up to 15 miles. (Depends on antenna height, and transmitter and antenna.	Commercial television transmitters and antennas.	Standard television receiver and antenna.	One-way audio and video (Two-way must be by another medium.)	One channel thus one course per time period.	May be able to add second outbound audio or data for use such as telex.
Instructional Television Fixed Service- ITFS	Radio waves (free space) AM-Video FM-Audio	Omni-directional Directional (Depending on system) Point to Point Point to Multi-point	Up to 40 miles. (Dependent on antenna height, transmitter power, radiation pattern.)	Commercial television transmitter but at higher frequency. For interactivity equipment needed at remote sites hub.	Standard television receiver with special antenna and doconcoverter. Small antenna timer may be required.	One-way with possibility of 2nd audio out. Some equipment offers audio return. (Two-way must be provided by another medium.	4 or more channels depending on FCC licenses. With 4 channel 4 courses per time frame.	May add second out or inbound channels. May add more channels with licenses from FCC.
FM Microwave Radio Simplex - one-way Duplex - two-way interactive using same dishes and wave guide.	Radio waves (free space) AM-Video FM-Audio	Directional	Up to 30 miles. (Dependent on antenna size, transmitter power, receiver sensitivity.)	Specialized equipment for this technology need FM low power transmitter. Transmitters & receivers are on same disk.	Specialized receivers and monitors.	Simplex - one-way audio and video Duplex - two-way audio and video	Depends on network configuration.	Availability of 1 to 2 audio subcarriers could be used for data.
Short Haul FM Microwave Radio simplex or duplex (see above)	Radio waves (free space) FM-Video FM-Audio	Directional	Up to 15 miles. (Dependent on antenna size, transmitter power, receiver sensitivity.)	Specialized equipment for this technology need FM low power transmitter. Transmitters & receivers are on same disk.	Specialized receivers and monitors.	Simplex - one-way audio and video Duplex - two-way audio and video	Depends on network configuration.	Availability of audio subcarriers that could be used for data.
AML Microwave AM-Video FM-Audio	Radio waves (free space) Behaves like a cable for user. Most likely used to piggy-back with cable services. (Would not be constructed by a school district.)	Directional	Up to 30 miles. (Dependent on antenna size, transmitter power, receiver sensitivity.)	Up-converters Down-converters modulators.	Standard Commercial or cable ready receiver.	Capable of two-two-way	Multiple channel both directions. Retransmission	None

Matrix 2 - continued

	Licenses	Initial Costs	Consulting Fees	Maintenance Cost	Equipment Life	Advantages	Limitation
Cable System AM	None	Exclusive of cable: cable: modulator $600 modulator $600 (One of each at each site.)	$1,500 to $2,000	Cable systems maintenance is the responsibility of Cable company. Maintenance confinmed to equipment modulators, remodulators.	10 years	Eliminate need for expensive items such as towers and dishes.	Primary limitation confined area served by cable company and access to cable system.
Fiberoptics System	None	Newest green light lasers have a 20 year life. Per channel cost (analog) depends on the number of channels and sites. Per site cost (analog) $20,000-$50,000	$1,500 to $2,000 site	Relatively unknown, 1% of system cost.	Unknown	1. Long Life 2. Low Maintenance	Cost
Satellite	FCC License for Uplinking	Downlink $3,500-$5,000 Uplink $125,000 plus.	Downlink-negligible Uplink-fairly expensive	Downlink-little Uplink-considerably expensive	10 years	Large coverage	1. Cost 2. Size of uplink
Compressed Video (Digital)	None	$100,000 per site	None		10 years	None	1. Less than full motion video. Movement is blurred. 2. Cost-very expensive.
Slow Scan	None	$10,000 for receive sites $15,000 for transmission sites.	None		10 years	None	1. Lack of motion. 2. Primarily series of still frames. 3. Time delays in building.

Matrix 2 - continued

Technologies	Licenses	Initial Cost (Excluding classroom cost which considered constant across technologies)	Consulting Fees	Maintenance Cost	Equipment Life	Advantages	Limitations
Low Power Television (LPTV)	Required.	$25,000 to $30,000 plus tower which depends on coverage needs and terrain range $25,000 to $100,000.	$1,500 to $2,000 per site.	3% to 5 % of system cost. (Vary from year to year.)	10 years	Low cost on receiving.	1. One-way channel limitations. 2. Channel availability. 3. Time to acquire license.
Instructional Television Fixed Service- ITFS	Required from FCC Available currently but long delays.	$25,000 per channel plus channel plus tower. $500 to $1,000 per receiving site.	$1,500 to $2,000 per site.	3% to 5% of system cost per year.	10 years	Multiple channels.	1. Time to acquire license. 2. Possibility of environmental interference with transmission.
FM Microwave Radio Simplex- one-way Duplex- two-way interactive same dishes and wave guide	Required from FCC 3 to 6 months.	Duplex-$35,000 plus towers range. $25,000 to $75,000	$1,500 to $2,000 per site.	3% to 5% of system cost per year.	10 years	1. Security 2. Can control who receives the signal. 3. Better spectrum use.	1. Channel availability. 2. Network size limitations. 3. Adding one channel approximately doubles cost.
Short Haul FM Microwave Radio simplex or duplex (see above)	Required from FCC 1 to 3.	Duplex-$15,000 plus towers range. $5,000 to $50,000	$1,500 to $2,000 per site.	1% to 4% of system cost per year.	10 years	1. Security 2. Can control who receives the signal. 3. Better spectrum use.	Same as FM microwave radio.
AML Microwave	Required of the cable company.	Would not build own cable system. Piggy-backed on existing system.	$1,500 to $2,000 per site.	3% to 5% of system cost per year.	10 years	Reasonable cost if piggy-backed onto cable system.	Availability depends on cable company.

SUMMARY AND CONCLUSIONS

Because of the widespread interest in distance education which is being precipitated by rapidly developing technologies, increased demands for education by many and varied groups and the need to provide these educational offerings in a convenient and economic manner, distance education promises to become a part of the mainstream of education. Technological advances that are improving the recording, transmission, reception, and versatility of the above mentioned technologies will enhance and promote their acceptance and utilization by educators and business and industry trainers alike. The older technologies such as the radio and telephone are being rediscovered along with the newer technologies of interactive television, computers, and interactive video-discs.

As users of distance delivery technologies, educators must be sensitive to the altered roles of instructors, the impact on learners, and the changes that are necessary in approaches to instructional design and curriculum. As was noted, each technology places certain unique conditions on the learning environment. As the two matrixes indicate, there are many factors to take into consideration both on the technical side as well as on the instructional side when considering the distance delivery of education. This report serves as an indication of what is currently happening and what the potential is for the future.

As a result of a review of the literature, interviews and on-site evaluations, several conclusions can be drawn.

1. Because of the investment that the various levels of education are making in terms of equipment and development, especially with the audio-graphic, full motion and computer technologies, it appears that the distance delivery of education is more than a passing fad. It can be anticipated that as the utilization of these distance delivery technologies increases, the cost will decrease expanding their use even further.

2. The impetus within education for distance delivery currently resides within the secondary schools. While there are many notable exceptions, post-secondary education and especially the vocational and technical education in particular have yet to take a proactive role in distance education. It would seem that vocational educators can use distance education to enhance existing programs and to reach new students. These new students could be the nontraditional students, the workers in business and industry, and high school students receiving post-secondary instruction at their high schools.

3. Educators should see themselves as part of the total community and should involve all interested parties when planning distance delivery systems that utilize technologies which would be of benefit to others. Cooperation between schools, the private sector, and the various governmental agencies would reduce the cost burden to all concerned and would allow for investment in state of the art technologies and services. This could enhance economic development especially in the rural areas.

4. The choice of which technology to use in a given situation depends on a number of factors that include the following: the objective(s) of the organization, initial cost, personnel, users, anticipated use, level of interactivity desired, technological infrastructure already in place, legal barriers, topographical considerations, equipment compatability, governmental and school jurisdictions, business service areas, and cost of operation.

5. Each technology has upper limits on capabilities, expansion potentials, and capacities. Knowledge of these factors is extremely important when considering interactive television.

6. Technical assistance during the planning and implementation stages from qualified and experienced consultants is of absolute necessity with the more sophisticated technologies such as interactive television. A feasibility study should include not only technical information but also should explore a variety of financing options that could include leasing, bartering, and bonding.

7. With the current interest in distance delivery at the various levels of education, state-wide coordination and articulation is necessary to maximize utilization of the various technologies, especially those associated with interactive television, to avoid duplication and to promote standardization of equipment wherever feasible.

8. Business and industry are using distance delivery to train, retrain, and to facilitate communication within the organization. Because of the savings in terms of cost and time, this trend will no doubt continue and expand in the future.

9. Research is needed to determine the effects of distance education on the learning environment. Previous research has been concerned with outcomes and learner preference. The focus of future research should be process oriented in an effort to determine which technologies are appropriate with the various content areas, how the various teaching techniques are impacted by the technologies, and how these technologies affect the learner and learning styles.

10. Finally, all instructors at all levels of education need to be made aware of the concepts and capabilities of distance education. Instructors teaching via distance delivery need practical in-service training and experience with the technologies employed prior to teaching at a distance. Experienced teachers with prior experience teaching via telecommunications should direct the training. Such training should include meaningful feedback and follow-up during the

initial learning phase and periodically thereafter until the instructor is comfortable and confident with the technology and the associated pedagogy.

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